



LANDCARE (MANCHESTER) LIMITED

STORMY WEST LANDFILL SITE, PYLE

Environmental Permit – EAWML34009

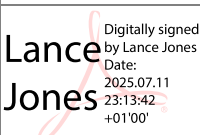
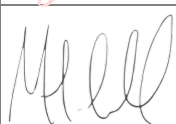
ENVIRONMENTAL MONITORING REPORT 2024

Report Type: Annual Review – Factual / Interpretive

Contract: Landcare Manchester Ltd.

Reference: CLOSED LANDFILL SITE

Action point:

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Some of the interpretation within this report is based upon information taken from previous reports and external sources at the time of the report issue. Full reliance is placed upon the accuracy of such information, and whilst due diligence is employed, any responsibility for incorrect information from these sources cannot be accepted.



NON-TECHNICAL SUMMARY

This report presents environmental monitoring data collected from Stormy West Landfill Site near Pyle in South Wales during 2024. The site has been closed for almost 30 years, having operated between 1985 and 1996.

Key findings from the 2024 monitoring include:

- **Water Quality:** Monitoring shows effective containment of landfill leachate with groundwater quality parameters remaining relatively stable throughout the year. The A48 monitoring point showed occasional spikes in ammoniacal nitrogen during drier periods.
- **Landfill Gas:** The gas management system is functioning effectively. Perimeter monitoring shows methane below 1% at most points with no significant off-site migration. Following system improvements in 2024, gas capture has improved, but declining generation now supports approximately 2.5 days of flaring per week.
- **Groundwater Levels:** Levels showed fluctuations between 2019 and 2024, with a decrease in 2022 followed by recovery in 2023, and a slight decrease in 2024 while remaining above 2022 levels. These changes correlate with regional rainfall patterns.
- **Surface Water:** Monitoring points at Pyle Spring and Kenfig Pool showed minimal impact from landfill operations, with all parameters well within specified limits.
- **Leachate Quality:** Leachate quality continues to improve, with decreasing concentrations of key contaminants compared to previous years, indicating ongoing stabilization of the landfill.
- **Compliance:** Based on the analysed parameters, the site is operating within expected environmental parameters, with no significant contamination detected in surrounding groundwater and surface water bodies.

The data indicates that the Stormy West Landfill site has a low probability of causing any significant environmental impact due to emissions and/or discharges. The site continues to progress through the latter stages of waste biodegradation, as evidenced by both leachate quality improvements and changing patterns in landfill gas generation.



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1. INTRODUCTION

Landcare (Manchester) Limited has prepared this report in accordance with its annual reporting responsibilities required by the site permit. This report presents the environmental monitoring data from the Stormy West landfill site and its potential impact upon the surrounding area. The site has been closed for almost 30 years.

The monitoring information is presented as a summary of water quality and landfill gas emissions data and observations in and around the site boundary, with regard to the site's journey toward surrender of the environmental permit.

The analytical results have been reported against relevant historical criteria and guidance issued within Waste Management Papers (these being the guidance available at the time the site was being operated and needed to comply with), EC directives/publications and UK guidance.

Groundwater analyses are tested against Drinking Water quality standards as water pollution represents the higher risk element to the environment for old landfills of this type at this late stage of biodegradation.

For landfill gas, the monitoring results have been assessed against relevant historic industry standards and best practice guidance for landfill sites (WMP27).

The data collected during the 2024 monitoring period has been abridged and reproduced within tables within the appendices.

2. BACKGROUND INFORMATION

The Stormy West Landfill Site was designed and operated under the principle of dilute and disperse which allowed the products of the biodegradation of the waste materials to be potentially rendered harmless by dilution, attenuation and interactions with the natural assimilative capacity of the limestone strata and hydrogeological pathways present within and beneath the site.

The site, prior to being landfilled, had been a disused limestone quarry. The void was filled and raised with a mix of household, industrial, commercial and some Special (at that time) Wastes (e.g. ACMs) as permitted by the Planning Permission and Waste Disposal Licence No. 5 (now an Environmental Permit) issued by the then Regulatory Authority, Ogwr Borough Council.

These waste types were landfilled between 1985 and 1996 (after which the site closed) and during this period approximately one million cubic metres of void space was landfilled.



Over the life of the site numerous reports have been presented relating to the co-disposal activities and assessments of the impact upon groundwater quality.

During the early part of the nineties appreciable concentrations of landfill gas were emitted resulting in the construction of an active gas extraction system utilizing a high temperature burner/flare.

In addition to, and complementing this, landfill gas was utilised for a few years at the mid to late nineties as a support fuel for a lime kiln. This was stopped due to the problems experienced by the kiln end user and the site reverted to the flaring/venting regime which continues to the present day, although gas yield and quality is considerably depleted, as would be expected, over the length of time since the last deposit of biodegradable waste took place. Gas flaring is currently (2025) managed in batch burns of approximately 3 days/week duration with the system turned off to allow re-charge for the remaining 4 days.

The site has been fully restored for several decades, with a low permeability clay cap which is seen to be in good order. Since 2016 the site restoration layer has supported an approved Solar Panel Electricity Generation System. Recent analytical results indicate a change in the dynamics of the landfill site possibly due to reduced infiltration caused by the presence of the solar panel cover.

3. LEGISLATIVE OVERVIEW

The principle environmental legislation governing the operation and any subsequent environmental impact of facilities is that of the Environmental Protection Act 1990 and regulations issued under it e.g. the Environmental Permit (EP).

In addition, publications such as the NRW (ex. EA) guidance documents and previous DOE Waste Management Papers (WMP) as appropriate have been referenced to indicate practices at that time and the minimum monitoring requirements. Related documents also include European Union Directives. It is worthy of note that this site, due to the date of closure in 1996, does not fall under the Landfill Regulations 2002.

Regarding groundwater, the 1998 EC Directive on the Quality of Water Intended for Human Consumption (98/83/EC) which is implemented in Wales by the Water Supply (Water Quality) Regulations have been used for the test results comparison purposes, although it is highly unlikely that the groundwater in the immediate vicinity would be used for potable purpose.

For landfill gas monitoring, the site follows the requirements set out in the Environmental Permit and industry best practice guidance.



4. GENERAL ENVIRONMENTAL SETTING OF THE SITE

Historic hydrogeological surveys and groundwater studies regarding the original landfill operations indicated that the predominant groundwater flow direction in the vicinity of the Stormy West site is north westwards, or westwards, although there was limited information which has suggested the flow could be reversed under certain circumstances.

It was also postulated that ultimate groundwater discharge was to the Bristol Channel, with flows passing at depth beneath Kenfig Pool and this was the reasoning behind monitoring at this location in addition to a monitoring point located at the nearby Pyle Spring surface water sources. These monitoring locations became a permit requirement and have been monitored in accordance since.

Previous studies suggest that there is significant attenuation of leachate coupled with a high dilution factor, increasing exponentially in a short distance away from the perimeter of the landfill.

This report notes that Stormy West Landfill lies just 0.7km NNW from the edge of Cornelly Quarry (See Location and Environmental Setting Plan – Appendix A), which is one of the deepest quarries in Wales, producing over 1 million tonnes of limestone a year. With an expected final depth of minus 75m AOD, publicly available information suggests that in 2023 the quarry owners installed a dewatering system that can extend to a total head of nearly 150m and be sufficient for an increased flow rate of up to 130 litres/second.

While quarrying activities have the potential to influence local groundwater dynamics, monitoring data from 2019-2024 shows that groundwater level fluctuations at the site correlate strongly with regional precipitation patterns. The significant rise in groundwater levels observed between 2022 and 2023 appears to be primarily a response to the recovery from severe drought conditions in 2022 (555.60 mm rainfall) to above-average rainfall in 2023 (1413.40 mm) and 2024 (1465.80 mm).

5. MONITORING AND SAMPLING DATA

In line with the requirements of the Permit, the data measured and recorded from various monitoring points in and around the site comply with guidance documents and are within permitted limits. The testing protocol has been based, as with previous annual reports, upon the requirements of the Permit and relevant historical regulatory standards.

The locations of the monitoring/sampling points used routinely to obtain samples are presented in Appendix B.

The sampling and testing protocol is presented below.



Table 1: Determinands tested for water quality

Parameter	Abbreviation	Parameter	Abbreviation
Acidity/alkalinity	pH	Conductivity	Cond.
Biological Oxygen Demand	BOD	Oxygen	O ₂
Chemical Oxygen Demand	COD	Total Organic Carbon	TOC
Ammoniacal Nitrogen	NH ₄	Total Organic Nitrogen	TON
Nitrate	NO ₃	Nitrite	NO ₂
Alkalinity	Alk	Chloride	Cl
Sulphate	SO ₄	Phosphate	PO ₄
Sodium	Na	Potassium	K
Copper	Cu	Magnesium	Mg
Calcium	Ca	Zinc	Zn
Cadmium	Cd	Lead	Pb
Chromium	Cr	Manganese	Mn
Iron	Fe	Nickel	Ni
Total Volatile Fatty Acids	VFA		

Similarly to previous years, the 2024 frequency of analyses/testing protocol for the determinands was:

- Leachate – monthly (EC, Temp, pH) and quarterly for full analysis at one location
- Groundwater – Quarterly analysis at three locations
- Surface water – Quarterly analysis at the Pyle and Kenfig Pool locations
- Landfill gas - Weekly monitoring at perimeter boreholes, selected in-waste wells, each gas extraction leg at the manifold and the flare

5.1 Leachate samples

There is one leachate monitoring point (gas well B5) which is based centrally within the waste mass.

The analytical results are presented in Appendix C. Review of this data exemplifies the expected general trend toward the pertinent Landfill Completion Criteria presented within WMP No: 26A (presented within Appendix D).

Throughout the 2024 monitoring period some slightly elevated results were noted for a limited number of determinands (substantially Chloride and Total Organic Carbon) when

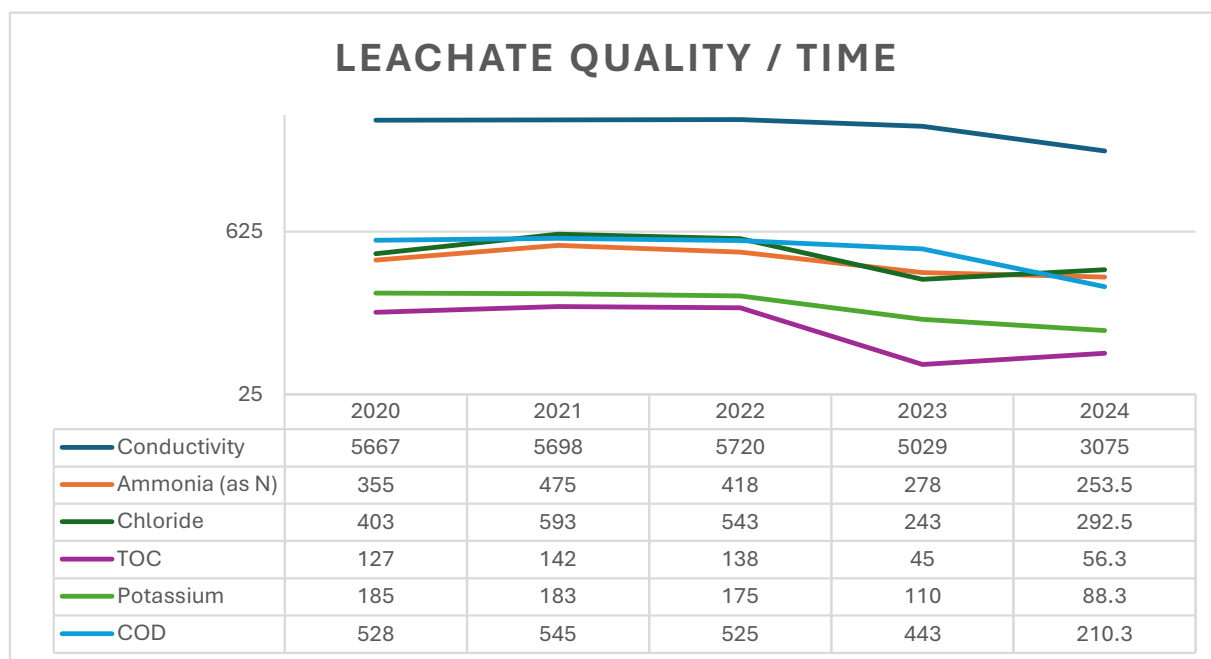


compared to 2023. However, these results still appear to represent a general downward trend over time, as shown in the table below.

Table 2: Leachate results

All results in PPM (mg/litre) except Conductivity (uS/cm) (LT – Less Than)

Determinand	Spec. limits	2024	2023	2022	2021	2020
Conductivity	LT 4000	3075	5029	5720	5698	5667
Ammonia (as N)	LT 5	253.5	278	418	475	355
Chloride	LT 2000	292.5	243	543	593	403
COD	No specified limit	210.3	443	525	545	528
TOC	LT 10	56.3	45	138	142	127
Potassium	LT 120	88.3	110	175	183	185



The three most frequently identified pollutants from a landfill leachate are Ammonia, Chloride and Chemical Oxygen Demand (COD). From the table of results, we can determine that the potential for these to cause harm is dropping over time, with 2024 Ammonia being around half of the 2021 result. Chloride is significantly below the completion criteria referenced and COD is showing a slowing downward trend over the period.



This downward trend is as expected for the site, with the waste mass continuing through the latter stages of waste biodegradation from anaerobic methanogenesis towards aerobic oxidation. This is also evidenced by the lower concentrations of landfill gas being produced (see section 5.4 below) and the detection of low concentrations of formic acid in the leachate samples which was the only volatile fatty acid consistently detected above the laboratory detection limit of 10 mg/l. The presence of formic acid, while at relatively low concentrations, indicates some ongoing biological activity within the waste mass but exemplifies the slowdown of activity between the stages of decomposition.

5.2 Surface Water

Two relatively distant surface water monitoring/sampling points are required to be monitored:

- Kenfig Pool: an expanse of still water lying to the west of the landfill site with significant amenity usage.
- Pyle Spring: a small stream which lies north westerly, skirting the edge of the Pyle industrial/factory estate location down strata of the site. (It is worthy of note that this water source could also be affected by industrial operations being performed upon this estate).

Both these locations have been referred to within Section 4 and, as expected, the results obtained from both these sources have generally not deviated from previous year's results. Surface water quality remains good with no indication of impact from the landfill site. Given the proximity of Cornelly Quarry to the SW and the relatively distant surface water monitoring points from Stormy West, it is highly unlikely that either of these locations could be impacted by the landfill.

Table 3: Surface Water results

Pyle Spring

Key Determinand	Spec. limits (WQS)	2024	2023	2022	2021
Conductivity	LT 1000	470	438	450	468
Ammonia (as N)	LT 4	0.10	0.11	0.19	0.17
Chloride	LT 200	25	25	32	31
COD	LT 30	5	14	20	11
Copper	LT 1	0.004	0.004	0.007	0.005
Manganese	LT 1	0.004	0.004	0.006	0.011



Kenfig Pool

Key Determinand	Spec. limits (WQS)	2024	2023	2022	2021
Conductivity	LT 1000	253	255	255	245
Ammonia (as N)	LT 4	0.05	0.04	0.02	0.05
Chloride	LT 200	30	36	39	19
COD	LT 30	12	13	15	12
Copper	LT 1	0.01	0.01	0.01	0.004
Manganese	LT 1	0.003	0.003	0.003	0.004

All results in PPM (mg/litre) except Conductivity (uS/cm) – (LT – Less Than)

NB - Results in bold show an exceedance over the previous annual monitoring period.

5.3 Groundwater

There are three groundwater monitoring/sampling points located around the site. The locations of these have been referred to within Section 3 and are shown in the Appendix C plan.

They are:

- A48: a borehole located adjacent to the A48 dual carriageway, and which lies to the south of the site, and bordering fields used for agriculture.
- GW2: a borehole (b/h2) located within the site car park area and lies to the southwest of the edge of the original quarry workings, but outside of the landfilled area.
- GW3: a borehole (b/h1) located near the site entrance at the outer extremity of the overall site area but further south than GW2, which again lies southwest of the original landfilled area.

Table 4 presents the depth of the groundwater within the monitoring boreholes at the time of sampling and the indicative leachate level within the gas well.



Table 4: Groundwater Rest Levels

Groundwater Water Levels (2019-2024)

Location	2019 (AOD)	2020 (AOD)	2021 (AOD)	2022 (AOD)	2023 (AOD)	2024 (AOD)
A48	84.7	86.8	82.3	80.5	87.4	85.99
GW2/BH2	88.0	88.3	87.4	82.5	89.0	88.71
GW3/BH1	83.7	85.7	86.1	85.5	87.8	85.95

Analysis of Groundwater Level Trends

Pattern Analysis

The groundwater monitoring data shows significant fluctuations in water levels between 2019 and 2024 across all three monitoring points. Most notably, there was a substantial decrease in 2022 followed by a dramatic recovery in 2023:

- A48: Decreased to 80.5m AOD in 2022, then increased by 6.9m to 87.4m AOD in 2023
- GW2/BH2: Decreased to 82.5m AOD in 2022, then increased by 6.5m to 89.0m AOD in 2023
- GW3/BH1: Showed more moderate fluctuations but still increased by 2.3m from 2022 to 2023

This synchronized pattern across all monitoring points suggests a regional hydrological factor affecting the entire area.

Correlation with Regional Precipitation Patterns

Analysis of rainfall data from nearby Swansea shows a strong correlation with the observed groundwater fluctuations:

Table 45: Groundwater Level Trends Year on Year

Year	Annual Rainfall (mm)	Groundwater Level Trend
2019	977.40	Moderate levels
2020	1302.80	Slight increase at most points
2021	2019.40	Relatively high levels
2022	555.60	Significant decrease at all points
2023	1413.40	Sharp recovery at all points
2024	1465.80	Slight decrease but still elevated



The extreme drought conditions in 2022 (555.60 mm, approximately 27% of the previous year's rainfall) align perfectly with the significant drop in groundwater levels that year. Similarly, the substantial increase in rainfall during 2023 (1413.40 mm, more than 2.5 times the 2022 rainfall) corresponds with the sharp recovery in groundwater levels. The 2024 rainfall data from Pennard (1465.80 mm) shows a continuation of above-average precipitation, slightly higher than 2023. This pattern is confirmed by additional regional weather stations (Llety Brongu and Llangynwyd), which show similar monthly distribution patterns despite some variations in absolute values. All regional stations recorded September as the wettest month of 2024, with additional significant rainfall in August and October.

Other Potential Influences on Local Hydrogeology

While regional precipitation patterns appear to be the primary driver of the observed groundwater fluctuations, it is important to note that the site is situated approximately 0.7km NNW from Cornelly Quarry, one of the deepest quarries in Wales. According to publicly available information, in 2023 the quarry installed a dewatering system capable of handling flow rates up to 130 liters/second.

Such quarrying operations could potentially influence local groundwater dynamics through:

- **Localized Drawdown:** Intensive dewatering activities could create localized cones of depression in the water table.
- **Altered Flow Paths:** Quarrying activities might intersect or modify natural groundwater flow paths in the limestone geology.
- **Barrier Effects:** Deep excavations can create barrier effects that alter regional groundwater movement patterns.

However, the strong correlation between regional rainfall patterns and groundwater levels suggests that precipitation is the dominant factor influencing the observed changes at the monitoring points. Any potential quarrying impact would be secondary and would require more specialized hydrogeological investigation to quantify.

Analysis of Landfill Leachate Impact on Groundwater Chemistry

A focused assessment was undertaken to determine the impact of landfill leachate on local groundwater chemistry, with key parameters such as Ammoniacal nitrogen, Chemical Oxygen Demand (COD), chloride, boron, and potassium monitored across all points. Results are summarised in Table 6 and the accompanying graph, which present year-on-year data for the principal determinands in the established tabular format, consistent with the rest of the document.



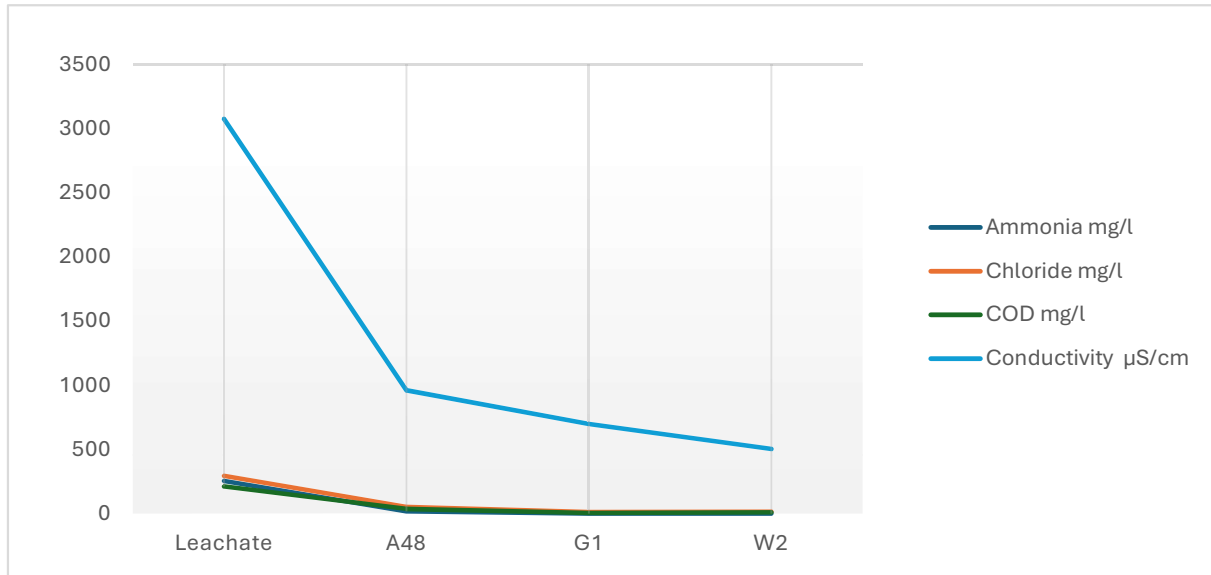
Table 6: Groundwater water results

Determinand	Spec. limits	2024	2023	2022	2021
A48					
Ammonia (as N)	LT 0.5	0.02	20.1	12.6	1.8
Manganese	LT 0.05	0.01	0.81	0.01	0.63
Potassium	LT 12	3.7	13	11	1
BH2/GW2					
Ammonia (as N)	LT 0.5	0.01	2.8	0.43	0.03
Manganese	LT 0.05	0.01	0.1	0.002	0.003
Potassium	LT 12	2.7	5	4	3
BH1/GW3					
Ammonia (as N)	LT 0.5	0.01	2	0.02	0.2
Manganese	LT 0.05	0.01	0.01	0.003	0.07
Potassium	LT 12	3.0	4	4	4

It is important to note that certain determinands exceeded required limits in previous years, most notably at A48 in 2022 and 2023. This was particularly influenced by drier periods, during which reduced groundwater volumes resulted in less dilution and temporary elevations in concentrations.

However, 2024 results show marked improvements at all monitoring points: every determinand is comfortably within the relevant compliance thresholds. There are now fewer, if any, outlying results, and any minor spikes have returned to levels expected based on historical experience, suggesting a return to seasonal baseline conditions. These findings support that containment measures are effective and that there is no ongoing evidence of landfill leachate migration affecting groundwater quality.

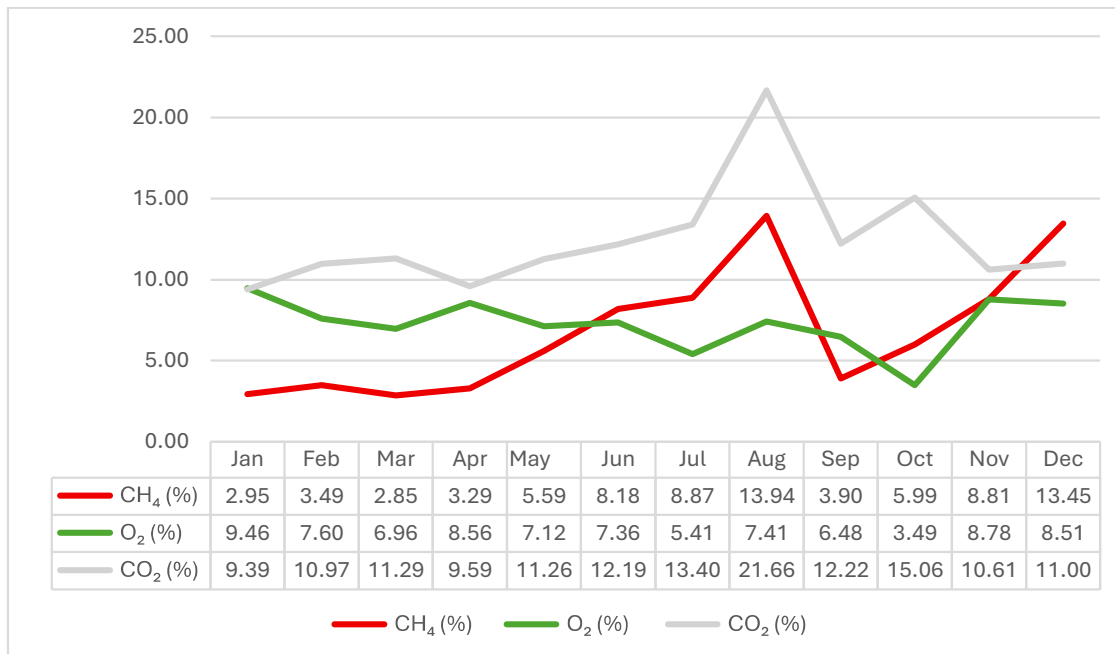
The observed improvements are reinforced by the presented data and graphical trends:



5.4 Landfill Gas

5.4.1 Landfill Gas Monitoring

Table 7: Landfill gas monitoring summary – Flare



The flare monitoring data for 2024 shows significant variations in methane concentrations throughout the year, reflecting the impact of a major overhaul of the landfill gas collection system.



The data demonstrates the progressive impact of the major gas collection system overhaul undertaken throughout 2024, addressing issues that had developed during the COVID-19 pandemic when site inspections were significantly reduced. Initial repairs to the landfill collector pipework were carried out in April, which led to modest improvements in methane concentrations from May through July (5.59% to 8.87%). During the subsequent months, a comprehensive gas balancing survey was conducted to optimize the system by closing unproductive wells and increasing suction on productive wells, resulting in a notable peak in August (13.94%).

Despite these efforts, consistent improvements were not sustained through September and October, suggesting persistent underlying issues. The breakthrough came when an underground supply pipe leak below the flare compound was identified and remediated. Following this critical repair and system re-sealing, methane concentrations showed dramatic and sustained improvement in December (13.45%), nearly matching the August peak but with greater stability.

However, preliminary data from early 2025 indicates that despite the system improvements, the site is now only able to sustain approximately 2.5 to 3 days of flare operation per week, as the flare requires a minimum of 20% methane to operate effectively. This suggests that while the collection system has been optimized, the underlying gas generation potential of the landfill is continuing its natural decline as the waste mass progresses through the later stages of decomposition.

Future Gas Production Forecast (2025-2035)

Based on the 2024 monitoring data and early 2025 observations, we can project the following declining gas production forecast for the next 10 years:

Table 8: Projected Landfill Gas Production Forecast (2025-2035)

Year	Estimated Peak CH ₄ (%)	Sustainable Flaring Days/Week	Annual CH ₄ Production (m ³)
2025	13-15%	2.5	~75,000
2026	12-14%	2.0	~60,000
2027	10-12%	1.5	~45,000
2028	8-10%	1.0	~30,000
2029	7-9%	0.75	~22,500
2030	6-8%	0.5	~15,000
2031	5-7%	0.5	~12,000
2032	4-6%	0.25	~7,500
2033	3-5%	Periodic	~5,000
2034	2-4%	Periodic	~3,000
2035	1-3%	Not sustainable	~1,500



This forecast is based on several key factors:

- The landfill closed in 1996, making the waste mass approximately 29 years old in 2025. Typical landfill gas generation curves show significant decline after 25-30 years.
- The current requirement for a minimum of 20% methane for flare operation, combined with the site only sustaining 2.5 days of flaring per week in early 2025, suggests that gas accumulation rates are already approaching critical thresholds for effective management.
- The observed methane concentrations in 2024, even after system optimization, averaged only 6.78%, with peaks of approximately 13-14% in the best months.
- Industry standard landfill gas models typically show exponential decline rates of 5-10% per year for sites of this age.

The forecast anticipates that by 2030, approximately 34 years after site closure, methane concentrations will likely fall below the threshold needed for regular flaring, necessitating a transition to alternative management approaches such as periodic venting, passive biofilters, or other low-flow gas treatment technologies.

By 2035, approximately 39 years after closure, methane generation is expected to be minimal and likely below levels requiring active management.

5.4.2 Perimeter Gas Monitoring

The perimeter gas monitoring boreholes (GBH01-GBH11) are designed to detect any lateral migration of landfill gas beyond the site boundary. The 2024 monitoring data shows:

- Most perimeter boreholes maintained methane concentrations below 1% throughout the year
- GBH03 showed occasional elevated methane readings (up to 11.6% in January)
- Oxygen concentrations were typically above 15% in most boreholes, indicating good atmospheric exchange
- No consistent pattern of increasing methane concentrations that would indicate significant lateral migration

5.4.3 In-waste Gas Wells

The in-waste gas wells provide information on gas generation within the waste mass. The 2024 monitoring data shows:

- Well B1 consistently showed elevated methane concentrations (8-23%)
- Wells A1 and B2 showed more variable methane concentrations (0-18%)



- Higher oxygen concentrations in A1 and B2 compared to B1 suggest potential air ingress
- Gas quality generally improved in the latter part of the year, with higher methane and lower oxygen

5.4.4 Gas Collection System

The gas collection system consists of four manifold legs (LegA-LegD) that collect gas from different areas of the site. The 2024 monitoring data shows:

- Variable gas quality across the four legs
- Leg A typically showed the highest methane concentrations (5-12%)
- Leg D showed increasing methane concentrations in the latter part of the year
- System adjustments were made throughout the year to optimize gas collection

The landfill gas monitoring data for 2024 indicates that the gas management system is functioning effectively, with the flare showing variable methane concentrations throughout the year. Perimeter gas monitoring indicates no significant lateral migration of landfill gas beyond the site boundary.

5.5 Rainfall Data

Rainfall data from multiple sources has been analyzed to understand the potential influence of precipitation on leachate generation and groundwater levels. For consistency with historical analyses in previous reports, the primary data source used is the Pennard weather station, supplemented by data from the NRW Llety Brongu rain gauge (8.3km NNE of the site) for additional context.

The monthly rainfall totals from the Pennard station are presented in Table 9.

Table 9: Monthly rainfall totals 2024 (Pennard station)

Month	Total Rainfall (mm)
January	96.2
February	246.0
March	154.4
April	130.6
May	79.2
June	28.0
July	87.8
August	91.8



September	241.4
October	147.4
November	76.2
December	86.8
Total	1465.8

The data shows significant precipitation throughout 2024, with a total annual rainfall of 1,465.8 mm, which is slightly higher than 2023 (1413.40 mm) and continues the recovery from the drought conditions of 2022 (555.60 mm). Particularly wet periods occurred in February (246.0 mm) and September (241.4 mm). This pattern is confirmed by additional regional weather stations, which show similar monthly distribution patterns despite some variations in absolute values.

Notable rainfall events in 2024 included:

- February 8-9: 32.6 mm
- March 16-17: 34.4 mm
- April 29-30: 30.4 mm
- September 26: 59.0 mm (Llety Brongu data)
- November 24: 48.6 mm (Llety Brongu data)
- December 5: 43.2 mm (Llety Brongu data)

A clear relationship has been identified between rainfall events, groundwater levels, and methane generation. Groundwater levels respond to rainfall with a typical lag of 2-4 weeks, while methane generation shows an inverse relationship with groundwater levels, with a 3–4-week lag between groundwater level changes and corresponding changes in methane concentrations.

The A48 monitoring point showed the most sensitivity to rainfall patterns, suggesting this location may be more hydraulically connected to the waste mass or in a preferential flow path. This point showed variable levels of ammoniacal nitrogen, with a spike in August (65 mg/l) but lower levels in other sampling events, suggesting potential concentration effects during drier periods and dilution during wetter periods.



6. CONCLUSION/ASSESSMENT

Based on the comprehensive monitoring data collected throughout 2024, the following conclusions can be drawn regarding the environmental performance of Stormy West Landfill Site:

Water Quality Assessment:

- No significant concentrations of toxic or phytotoxic determinands have been identified in any water samples.
- Groundwater quality results show no significant divergence from 2023 and previous years for mobile and soluble determinands, with most parameters well within specified limits.
- Leachate quality continues to improve, with decreasing concentrations of key contaminants (ammonia, COD, potassium) compared to previous years, suggesting ongoing stabilization of the landfill.
- The significant difference in chemical composition between leachate and groundwater monitoring points indicates effective containment of landfill leachate.
- The A48 monitoring point showed occasional spikes in ammoniacal nitrogen during drier periods, suggesting potential seasonal effects.

Landfill Gas Management:

- The landfill gas management system is functioning effectively overall, with variable methane concentrations throughout the year.
- Perimeter gas monitoring indicates no significant lateral migration of landfill gas beyond the site boundary, with most perimeter boreholes maintaining methane concentrations below 1%.
- Despite the successful optimization of the gas collection system in 2024, early 2025 data showing limited sustainable flaring periods (approximately 2.5 days per week) confirms that the site is progressing through its natural gas generation decline curve. Based on these observations, we project that regular flaring operations may become unsustainable by approximately 2030, with minimal gas generation expected by 2035. This timeline aligns with typical landfill gas generation models for sites of this age and supports long-term planning for eventual transition to passive gas management and potential permit surrender.

Groundwater Levels:

- Significant fluctuations in groundwater levels were observed between 2019 and 2024, with a substantial decrease in 2022 followed by a dramatic recovery in 2023



- Analysis of regional rainfall data shows a strong correlation with these changes, with 2022 being an extreme drought year (555.60 mm) followed by significantly higher rainfall in 2023 (1413.40 mm) and 2024 (1465.80 mm).
- This weather-based explanation provides the most parsimonious interpretation for the observed groundwater level changes.
- Groundwater levels showed expected seasonal fluctuations within each year, with higher levels in winter months and lower levels in summer months.
- The elevated groundwater levels in 2023-2024 may be beneficial in reducing leachate migration from the site.

Surface Water Impact:

- Surface water monitoring points (Pyle Spring and Kenfig Pool) showed minimal impact from landfill operations, maintaining good water quality throughout the year with all parameters well within specified limits.

Site Management:

- The engineered cap with solar panel installation continues to function effectively, reducing infiltration and subsequent leachate generation.
- The site is progressing through the latter stages of waste biodegradation, as evidenced by both leachate quality improvements and changing patterns in landfill gas generation.
- The presence of formic acid as the only consistently detected volatile fatty acid in leachate samples indicates the landfill is in the later stages of decomposition.

Overall Environmental Impact:

- Based on the analysed parameters, the site operates within expected environmental parameters, with no significant contamination detected in the surrounding groundwater and surface water bodies.
- The data indicates that the Stormy West landfill site has a low probability of causing any significant environmental impact due to emissions and/or discharges.

In summary, the Stormy West Landfill Site continues to demonstrate improving environmental performance with minimal impact on surrounding receptors. The site is showing expected signs of stabilization for a closed landfill of this age, with ongoing improvements in leachate quality and management of landfill gas generation.

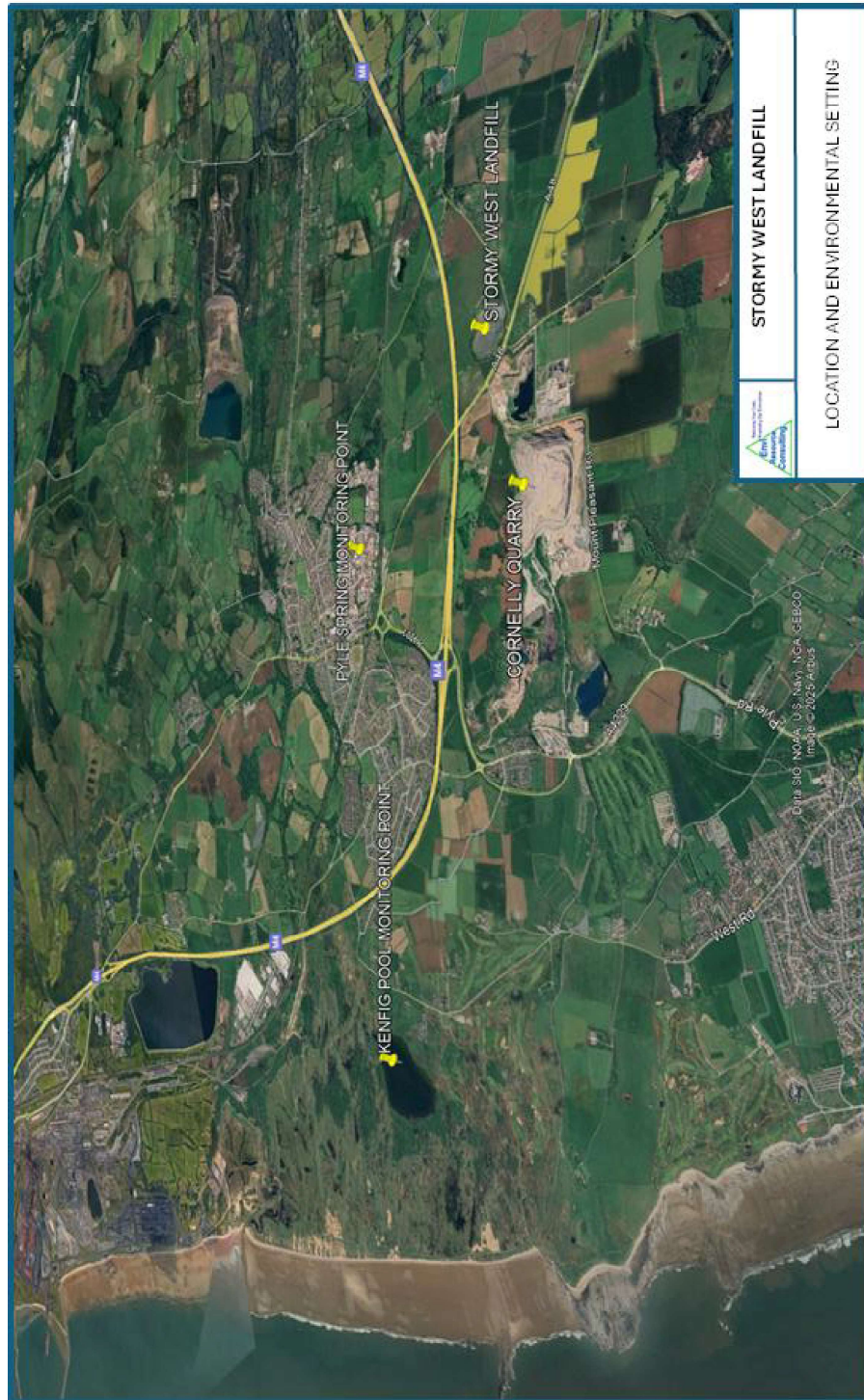


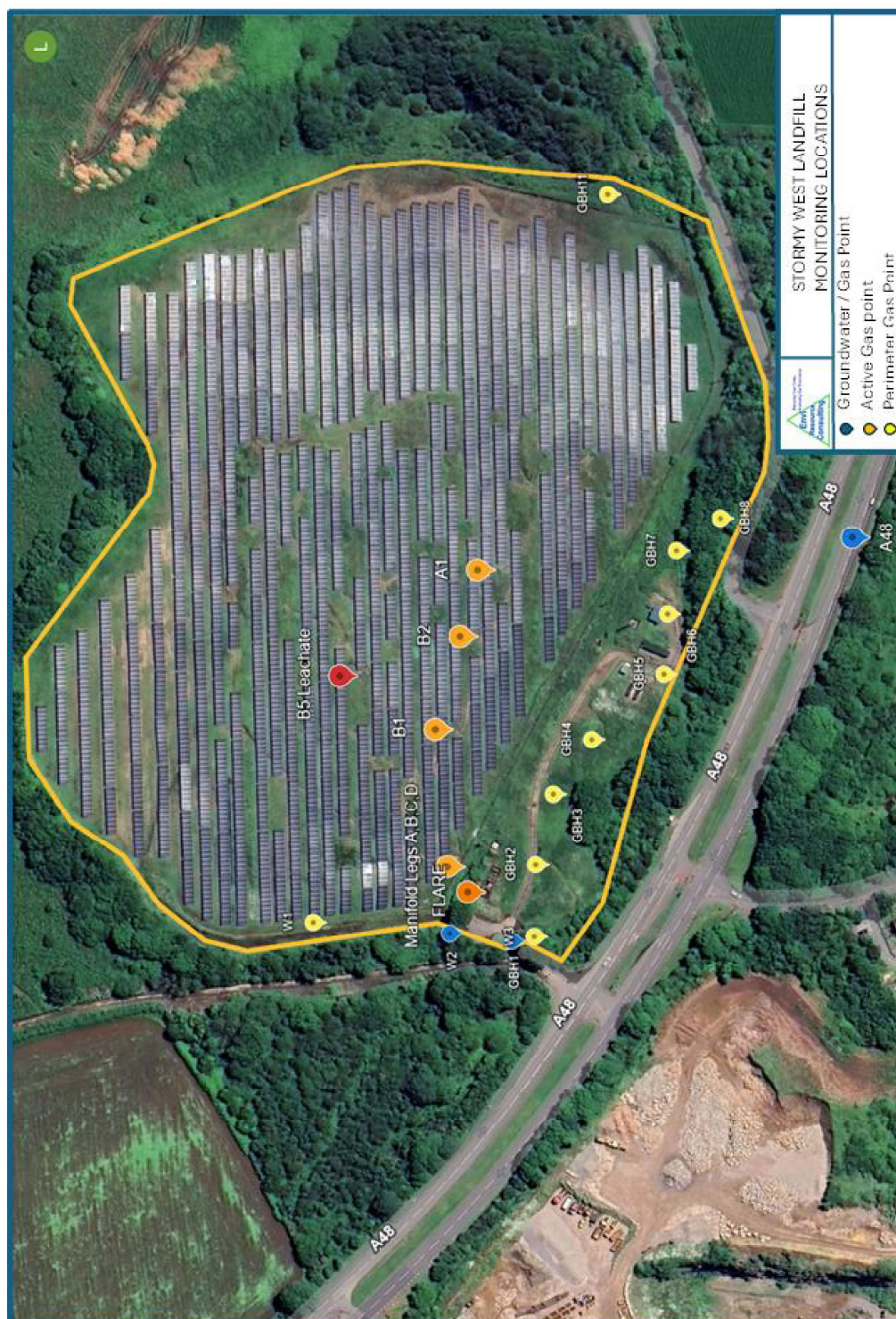
APPENDICES

- A. Site Location and Environmental Setting plan
- B. Monitoring/sampling points plan
- C. Sampling point analytical results
- D. Standards used for assessment of water quality
- E. Landfill gas monitoring data



APPENDIX A - SITE LOCATION AND ENVIRONMENTAL SETTING PLAN







APPENDIX C - SAMPLING POINT ANALYTICAL RESULTS

C1. Leachate Analytical Results 2024

Parameter	Units	10/12/2023	23/03/2024	09/11/2024	28/12/2024	Mean
pH	pH Units	7.4	7.6	7.2	7.2	7.4
Electrical Conductivity	µS/cm	4600	3300	4700	2600	3800
Sulphate as SO ₄	mg/l	29	17.9	9.32	23.7	20.0
Chloride	mg/l	520	290	570	170	388
Ammoniacal Nitrogen	mg/l	320	250	450	220	310
TOC	mg/l	95.9	67.3	88.6	46.3	74.5
COD	mg/l	950	240	450	140	445
BOD	mg/l	55	17	18	18	27
Potassium	mg/l	100	86	160	73	105
Sodium	mg/l	410	290	550	210	365
Calcium	mg/l	140	140	120	210	153
Magnesium	mg/l	52	56	82	58	62
Iron	mg/l	1.5	0.11	0.35	0.75	0.68
Boron	µg/l	110	1600	3000	1200	1478
Formic Acid	mg/l	41	14	31	<10	24

C2. Surface Water Analytical Results 2024 - Pyle Spring

Parameter	Units	10/12/2023	23/03/2024	09/11/2024	28/12/2024	Mean
pH	pH Units	7.6	7.8	8.0	7.9	7.8
Electrical Conductivity	µS/cm	370	470	460	480	445
Sulphate as SO ₄	mg/l	9.35	13.1	15.6	14.9	13.2
Chloride	mg/l	19	25	25	27	24
Ammoniacal Nitrogen	mg/l	0.12	0.10	0.057	0.15	0.11
TOC	mg/l	5.78	2.14	1.89	2.63	3.11
COD	mg/l	16	3.1	3.6	7.8	7.6
BOD	mg/l	5.4	<1.0	1.4	1.3	2.3
Dissolved Oxygen	mg/l	5.7	9.6	9.7	9.4	8.6



C3. Surface Water Analytical Results 2024 - Kenfig Pool

Parameter	Units	10/12/2023	23/03/2024	09/11/2024	28/12/2024	Mean
pH	pH Units	8.0	7.9	7.9	7.9	7.9
Electrical Conductivity	µS/cm	240	300	220	240	250
Sulphate as SO ₄	mg/l	3.16	4.63	3.07	3.54	3.6
Chloride	mg/l	31	30	29	29	30
Ammoniacal Nitrogen	mg/l	0.049	0.062	0.038	0.039	0.047
TOC	mg/l	6.4	4.17	5.6	5.44	5.4
COD	mg/l	13	12	12	11	12
BOD	mg/l	8.5	2.7	1.1	1.6	3.5
Dissolved Oxygen	mg/l	11	9	9.3	10	9.8

C4. Groundwater Analytical Results 2024 - A48

Parameter	Units	10/12/2023	23/03/2024	09/11/2024	28/12/2024	Mean
pH	pH Units	7.1	7.2	7.1	7.1	7.1
Electrical Conductivity	µS/cm	990	810	750	880	858
Sulphate as SO ₄	mg/l	80.9	103	90.6	90.3	91.2
Chloride	mg/l	83	47	35	44	52.3
Ammoniacal Nitrogen	mg/l	0.05	<0.015	0.016	<0.015	0.02
TOC	mg/l	2.42	1.46	2.56	1.93	2.09
COD	mg/l	9.8	7.9	73	17	26.9
BOD	mg/l	6.2	<1.0	5.4	1.5	3.5
Potassium	mg/l	2.6	3	4.8	4.5	3.7
Iron	mg/l	0.005	<0.004	<0.004	<0.004	<0.004
Manganese	mg/l	0.005	<0.004	<0.004	<0.004	<0.004



C5. Groundwater Analytical Results 2024 - GW2

Parameter	Units	10/12/2023	23/03/2024	09/11/2024	28/12/2024	Mean
pH	pH Units	7.6	7.7	7.4	7.4	7.5
Electrical Conductivity	µS/cm	290	320	510	540	415
Sulphate as SO ₄	mg/l	8.7	10.9	17.4	18.9	14.0
Chloride	mg/l	13	13	11	23	15.0
Ammoniacal Nitrogen	mg/l	0.032	<0.015	<0.015	0.016	0.01
TOC	mg/l	3.24	1.39	1.75	1.81	2.05
COD	mg/l	44	3.7	18	7.7	18.4
BOD	mg/l	5.4	1.1	<1.0	1.2	2.2
Potassium	mg/l	1.7	2	3.1	2.8	2.4
Iron	mg/l	0.019	0.007	0.005	<0.004	0.01
Manganese	mg/l	0.019	0.007	0.005	<0.004	0.01

C6. Groundwater Analytical Results 2024 - GW3

Parameter	Units	10/12/2023	23/03/2024	09/11/2024	28/12/2024	Mean
pH	pH Units	7.2	7.3	7.1	7.1	7.2
Electrical Conductivity	µS/cm	770	590	700	770	708
Sulphate as SO ₄	mg/l	39.7	21.6	34.9	32.2	32.1
Chloride	mg/l	26	11	10	16	15.8
Ammoniacal Nitrogen	mg/l	5.8	<0.015	0.029	<0.015	1.5
TOC	mg/l	2.07	1.5	2.34	1.77	1.92
COD	mg/l	9.9	2.9	4.2	3.7	5.2
BOD	mg/l	1.4	<1.0	<1.0	1.2	0.9
Potassium	mg/l	2.5	2.7	3.5	3.3	3.0
Iron	mg/l	0.012	<0.004	<0.004	<0.004	<0.01
Manganese	mg/l	0.012	<0.004	<0.004	<0.004	<0.01



APPENDIX D - STANDARDS USED FOR ASSESSMENT OF WATER QUALITY

Determinand	Units	Leachate	Groundwater	Surface water
pH	units	6.5 to 8.5	6.5 to 10.0	5.5 to 9(g)
Conductivity	us/cm	4000	2500	1000 (g)
Dissolved O ₂	mg/l O	n/a	n/a	n/a
BOD	mg/l O	n/a	n/a	<7 (g)
COD	mg/l O	n/a	n/a	30 (g)
Alkalinity	mg/l CaCO ₃	n/a	n/a	n/a
Ammoniacal N	mg/l N	5	0.5	4
TON	mg/l N	n/a	n/a	n/a
Nitrate	mg/l N	500	50	n/a
Nitrite	mg/l N	1	0.5	n/a
Chloride	mg/l	2000	250	200 (g)
Sulphate	mg/l	2500	250	250
Sodium	mg/l	1500	200	n/a
Potassium	mg/l	120	12	n/a
Copper	mg/l	1	2	1 (g)
Magnesium	mg/l	500	0.05	n
Calcium	mg/l	1000	250	n
Zinc	mg/l	1	5	5
Cadmium	mg/l	0.05	0.005	0.005
Lead	mg/l	0.5	0.025	0.05
Chromium	mg/l	0.5	0.05	0.05
Manganese	mg/l	0.5	0.05	1 (g)
Iron	mg/l	2	0.2	2
Nickel	mg/l	0.5	0.02	n/a
Volatile fatty Acids	mg/l	n/a	n/a	n/a
Phosphate	mg/l	n/a	n/a	n/a
TOC	mg/l	10	n/a	n/a

Limits derived from the following guidance/regulations:

- Leachate - example completion criteria - WMP No. 26A
- Groundwater - Water Supply (Water Quality) Regulations
- Surface water - EC Directive 75/440/EEC



APPENDIX E - LANDFILL GAS MONITORING DATA

E1. Monthly Average Methane Concentrations (%) at Flare 2024

Month	CH ₄ (%)	O ₂ (%)	CO ₂ (%)	Balance Gas (%)
January	2.95	9.46	9.39	78.20
February	3.49	7.60	10.97	77.94
March	2.85	6.96	11.29	78.90
April	3.29	8.56	9.59	78.56
May	5.59	7.12	11.26	76.03
June	8.18	7.36	12.19	72.27
July	8.87	5.41	13.40	72.32
August	13.94	7.41	21.66	56.99
September	3.90	6.48	12.22	77.40
October	5.99	3.49	15.06	75.46
November	8.81	8.78	10.61	71.80
December	13.45	8.51	11.00	67.04
Average	6.78	7.26	12.39	73.57

E2. Monthly Average Methane Concentrations (%) at Perimeter Boreholes 2024

Month	GBH01	GBH02	GBH03	GBH04	GBH05	GBH06	GBH07	GBH08	GBH11
January	0.00	2.08	5.99	0.11	0.02	0.05	0.03	0.03	0.01
February	0.00	1.23	7.21	0.17	0.01	0.04	0.03	0.03	0.04
March	0.00	0.01	5.42	0.59	0.00	0.00	0.00	0.01	0.01
April	0.03	0.01	6.56	0.38	0.03	0.03	0.02	0.03	0.01
May	0.00	0.00	7.88	0.51	0.08	0.04	0.04	0.03	0.01
June	0.00	0.00	6.18	0.66	0.00	0.00	0.00	0.00	0.00
July	0.00	0.00	7.04	0.94	0.00	0.06	0.00	0.00	0.00
August	0.07	0.04	5.37	0.19	0.07	0.08	0.08	0.06	0.08
September	0.00	0.03	1.27	0.07	0.00	0.00	0.00	0.00	0.00
October	0.00	0.00	3.20	0.34	0.00	0.00	0.00	0.00	0.00
November	0.08	0.07	3.97	1.24	0.06	0.08	0.07	0.06	0.08
December	0.09	0.09	3.68	1.03	0.62	0.08	0.07	0.08	0.09
Average	0.02	0.30	4.90	0.52	0.08	0.04	0.03	0.03	0.03



E3. Monthly Average Methane Concentrations (%) at In-waste Gas Wells 2024

Month	A1	B1	B2
January	1.41	8.27	0.56
February	1.17	3.84	0.33
March	1.90	9.38	17.58
April	1.62	8.21	16.91
May	1.58	14.97	18.26
June	1.66	16.44	17.58
July	1.58	13.23	16.91
August	0.76	18.80	16.91
September	0.27	12.02	0.56
October	0.19	12.02	0.33
November	1.43	19.44	0.76
December	1.67	19.44	0.33
Average	1.27	13.01	8.92

E4. Monthly Average Methane Concentrations (%) at Manifold Legs 2024

Month	Leg A	Leg B	Leg C	Leg D
January	4.95	3.29	2.50	2.76
February	3.68	0.38	6.99	6.34
March	4.61	2.38	2.61	3.71
April	6.17	3.72	2.55	3.97
May	7.45	6.47	5.09	4.71
June	9.57	6.78	6.16	5.45
July	9.09	8.03	7.31	13.31
August	10.70	10.15	7.20	13.47
September	5.63	6.67	3.53	2.50
October	7.61	6.06	5.26	4.88
November	10.09	15.99	16.20	19.59
December	18.80	19.10	15.98	21.15
Average	8.20	7.42	6.78	8.49

Notes:

1. The flare system underwent a major overhaul during 2024, with initial repairs in April followed by a comprehensive gas balancing survey and culminating in the identification and repair of a critical underground pipe leak in late 2024.
2. The significant improvement in methane concentrations in December reflects the successful completion of system repairs, particularly the elimination of a major air ingress point from an underground supply pipe leak.
3. Preliminary data from early 2025 indicates that despite system optimization, the site can now only sustain approximately 2.5 days of flare operation per week due to the flare's requirement for a minimum of 20% methane.
4. The perimeter borehole data confirms that lateral migration of landfill gas remains well controlled, with all monitoring points showing methane concentrations consistently below regulatory thresholds.